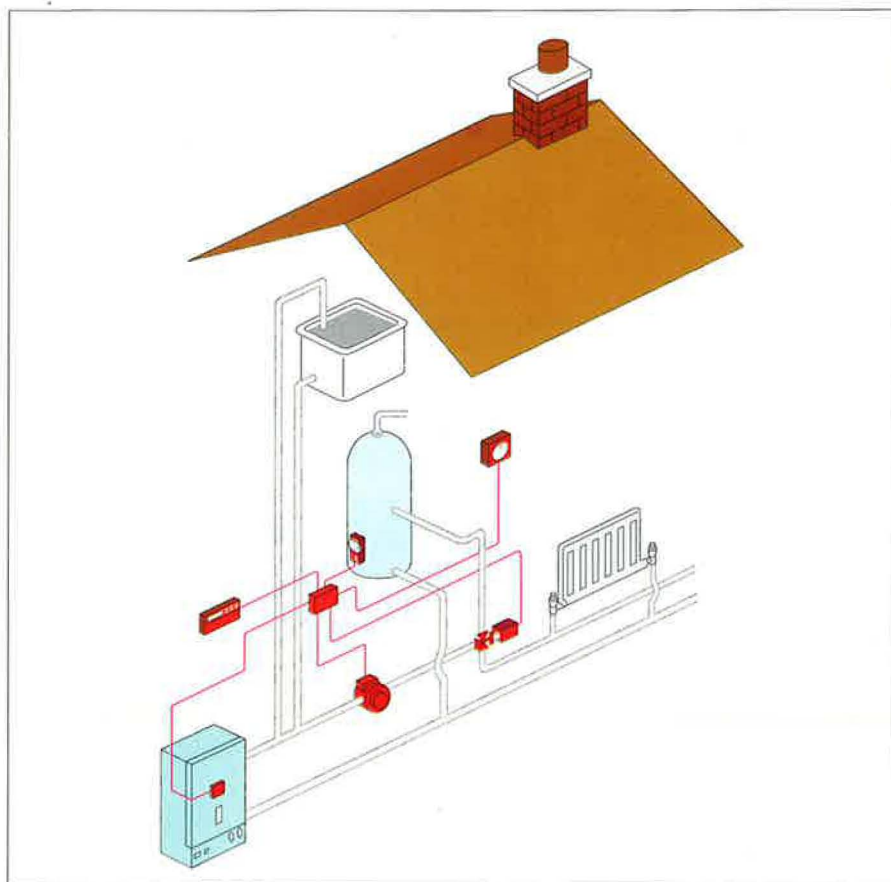


Upgrading controls in domestic wet central heating systems – a guide for installers



The following organisations endorse this Guide

TACMA



NAPH & MSC



Energy Saving Trust

Most householders would like to see their heating costs reduced, but few have a full understanding of the controls available to help achieve this. The majority rely upon designers and installers for advice on their heating systems, particularly when they are considering an upgrade.

A move to a fully pumped system with a programmer, room thermostat and cylinder thermostat can improve the controllability of the system and reduce heating costs by up to a quarter. Upgrading controls generally pays for itself in under six years, and

provides the additional benefit of improved comfort. Incorporating better controls with a replacement heating system is even more cost-effective.

Good controls are crucial to the efficient performance of domestic central heating systems. Even well-designed systems can perform badly if the controls fitted are inadequate or incorrectly wired/installed.

Poor controls can lead to unsatisfactory comfort conditions for the householder. They can also waste energy where a poorly controlled heating system continues to

supply heat when desired temperatures have been reached. Energy wastage is expensive and causes the emission of unnecessary, and potentially harmful, gases into the environment.

This Guide provides installers with general advice to give householders on the controls upgrade packages most suitable for their heating systems. It shows typical costs and financial benefits to householders of each upgrade package. It also highlights the improvements to comfort levels and the environmental advantages of better controls.



ENERGY EFFICIENCY

“ Good use of well-specified controls reduces heating costs ”

UPGRADING CONTROLS

SYSTEM CHECKLIST

How to use the Guide

- Work through the system checklist to determine the type of existing heating system and controls.
- Compare the controls fitted to the existing system with the schematic diagrams shown.
- Identify the upgrades necessary to bring the system up to a good level of control for energy efficient operation.
- Identify the benefits of the control upgrade package and communicate these to the householder.
- This page should be photocopied and used repeatedly.

(PLEASE RING ANSWERS)

SYSTEM

CONTROLS

UPGRADE?

A. Boiler description?

Fuel: Natural gas LPG Oil etc
Thermal capacity High Low
Condensing boiler Yes No
Boiler output kW (Btu)

B. Is it a full gravity system?

YES – Full gravity system GO TO (F)

NO – CONTINUE TO (C)

(These systems have no pump and often have pipework larger than 28mm diameter for heating and hot water)

C. Is it a semi-gravity system?

YES – Semi-gravity system GO TO (F)

NO – CONTINUE TO (D)

(The circulating pump only serves the heating circuit in these systems)

D. Is it a fully pumped system?

YES – Fully pumped system GO TO (G)

NO – CONTINUE TO (E)

(The boilers in these systems generally only have two water connections)

E. Is it a combi boiler system?

YES – Combi boiler system GO TO (M)

NO – Carry out further checks on system GO TO (A)

(Combi boilers have a mains water supply connection and a hot water feed pipe. These systems have no hot water storage cylinder)

F. Upgrade to fully pumped

Usually worth upgrading



G. Are there any motorised valves?

(Either a single three port or a pair of two port valves can be used)

NO

Upgrade

YES

Adequate



H. Is there a time switch or programmer?

NO

Upgrade

If **YES**, can it control heating and hot water separately?

NO

Upgrade

YES

Adequate



I. Is there a room thermostat?

NO

Upgrade

YES

Adequate



J. Is there a cylinder thermostat?

NO

Upgrade

YES

Adequate



K. Is there an electrical interlock between the thermostats and the boiler?

NO

Upgrade

YES

Adequate

(Turn all the thermostats down, if the boiler continues to fire then there is no interlock)



L. Are there thermostatic radiator valves (TRVs) in most rooms?

NO

Consider upgrade

YES

Adequate

M. Is there a time switch or programmer?

NO

Upgrade

YES

Adequate



N. Is there a room thermostat?

NO

Upgrade

YES

Adequate



O. Are there thermostatic radiator valves (TRVs) in most rooms?

NO

Consider upgrade

YES

Adequate

Care should be taken to ensure that any upgrade provides adequate control of room temperature, the temperature of stored hot water and the ON/OFF times of the heating and hot water. The control system should also switch off the boiler when no heat is needed. The cost-effectiveness of these measures is outlined on the page headed 'benefits' and should be taken into account when giving advice to customers.

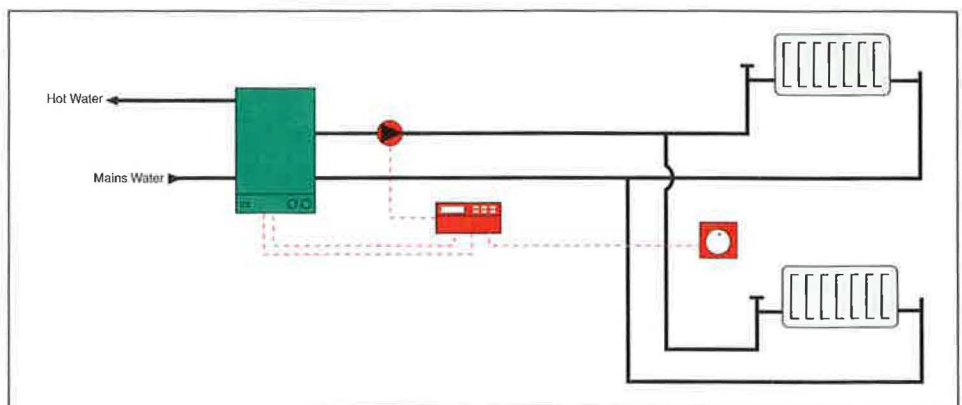
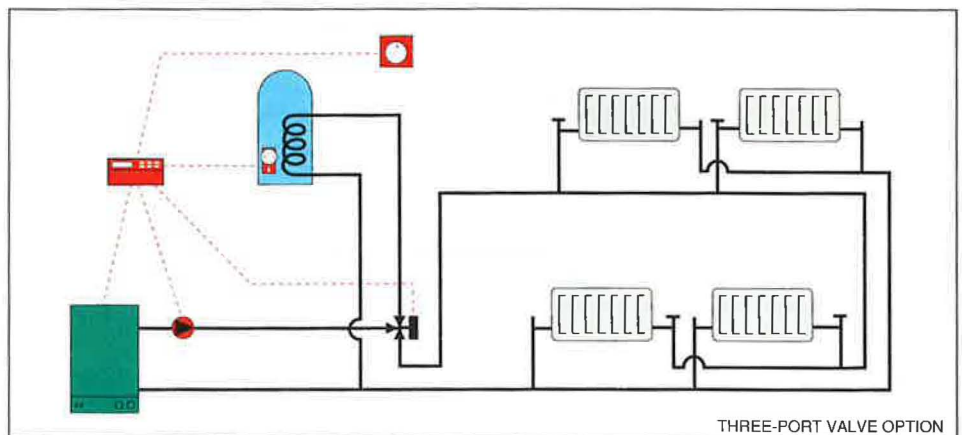
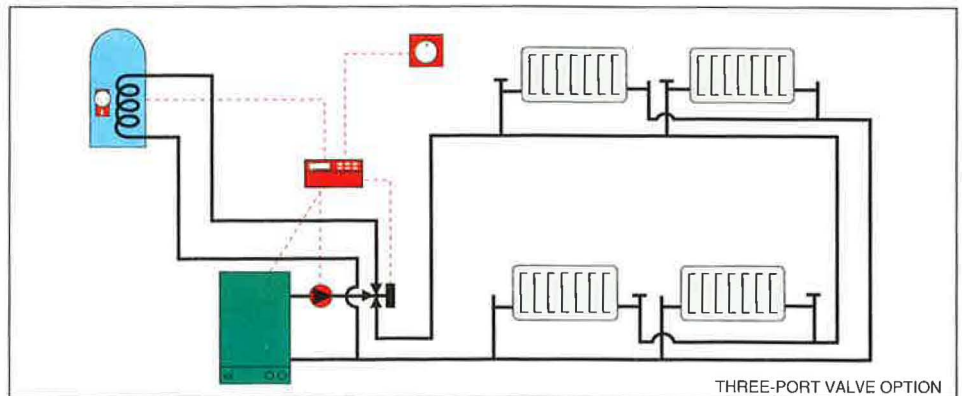
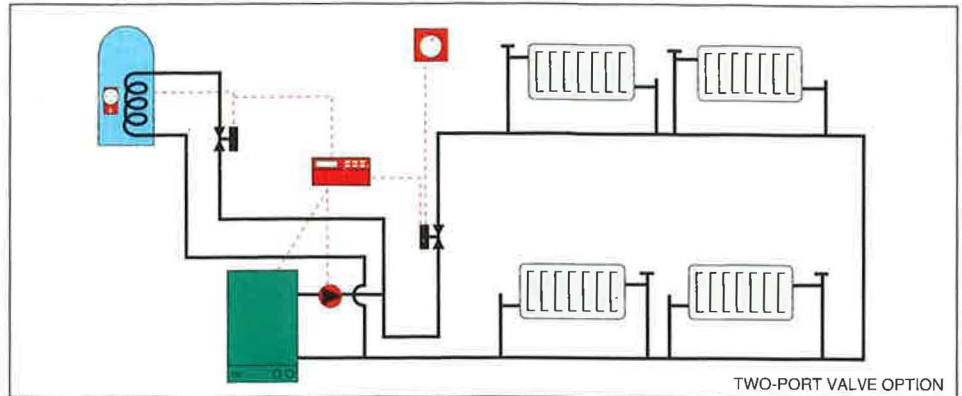
GRAVITY SYSTEMS

Both semi and full gravity systems require alterations to the system pipework from the boiler to introduce a single pump to supply heating and hot water. The upgraded system then gives faster response to react to the close control provided by modern thermostats, time controls and motorised valves.

Two-port valves are most commonly used in this circumstance to share the available heat between heating and hot water, although this can be achieved using a three-port valve.

A room thermostat, positioned in a living room (away from a heat source), is essential to prevent overheating and to achieve comfortable conditions throughout the heating season.

A programmer ensures that the heating is only on when required and a cylinder thermostat avoids overheating the stored hot water. It may also be advantageous to upgrade the hot water cylinder at this time. An electrical interlock between these controls and the boiler is essential to ensure that the boiler does not cycle unnecessarily when there is no demand for heat.

**FULLY PUMPED SYSTEMS**

Upgrading this system is straightforward as little or no pipework alteration is required. Where necessary the controls should be upgraded to a minimum standard based upon the two-port valve option or the three-port valve option together with a room thermostat, a cylinder thermostat and a programmer. An electrical interlock between these controls and the boiler is essential to ensure that the boiler does not cycle unnecessarily when there is no demand for heat.

COMBI BOILER SYSTEMS

Hot water temperatures are controlled by thermostats on the boiler and water is only heated as necessary. The main upgrade is therefore a room thermostat and a programmer, or a programmable room thermostat, to minimise the running times.

THERMOSTATIC RADIATOR VALVES

The addition of thermostatic radiator valves (TRVs) to any of the above systems will provide the extra benefits of individual room temperature control and even greater energy savings. These can be installed in all rooms except where the central room thermostat is positioned. Added comfort is usually gained due to the individual control and by preventing localised overheating from solar gains, appliances, etc. They are particularly useful in rooms where desired temperatures are different to those in the main living rooms, eg bedrooms. TRV systems should always be fitted with a by-pass, preferably automatic, and special TRVs should be used in single pipe or gravity systems.

UPGRADING CONTROLS

BENEFITS

The icons in this table give approximate costs and savings based on typical existing houses with annual gas heating costs of £375 for terraced, £425 for semi-detached and £600 for detached.



TERRACED



SEMI-DETACHED



DETACHED

Full gravity (no controls) to Fully pumped <ul style="list-style-type: none"> • Programmer • Room thermostat • Cylinder thermostat • Motorised valve(s) 	CAPITAL COST			
	ANNUAL COST SAVINGS & REDUCED CO ₂ EMISSIONS			
	PAYBACK PERIOD			
	COMFORT IMPROVEMENTS			
Semi-gravity (no controls) to Fully pumped <ul style="list-style-type: none"> • Programmer • Room thermostat • Cylinder thermostat • Motorised valve(s) 	CAPITAL COST			
	ANNUAL COST SAVINGS & REDUCED CO ₂ EMISSIONS			
	PAYBACK PERIOD			
	COMFORT IMPROVEMENTS			
Fully pumped (no controls) to Fully pumped <ul style="list-style-type: none"> • Programmer • Room thermostat • Cylinder thermostat • Motorised valve(s) 	CAPITAL COST			
	ANNUAL COST SAVINGS & REDUCED CO ₂ EMISSIONS			
	PAYBACK PERIOD			
	COMFORT IMPROVEMENTS			
Combi boiler (no controls) to Combi boiler <ul style="list-style-type: none"> • Time switch • Room thermostat 	CAPITAL COST			
	ANNUAL COST SAVINGS & REDUCED CO ₂ EMISSIONS			
	PAYBACK PERIOD			
	COMFORT IMPROVEMENTS			

Thermostatic Radiator Valves

Additional benefits can be achieved by fitting TRVs at the same time as any of the control upgrades recommended above.

Where TRVs are fitted as a stand alone measure then capital costs will be greater but payback periods will still be as short as 4-6 years.

Additional Capital Cost



Additional Cost Savings (Reduced CO₂ emissions)



Payback Period



Additional Comfort Improvements



Capital cost

	up to £150
	£150 - £300
	£300 - £450

Annual cost savings/ Reduced CO₂ emissions

	up to £50 (0.5 tonnes CO ₂)
	£50 to £85 (0.5-0.85 tonnes CO ₂)
	above £85 (0.85 tonnes CO ₂)

Payback period

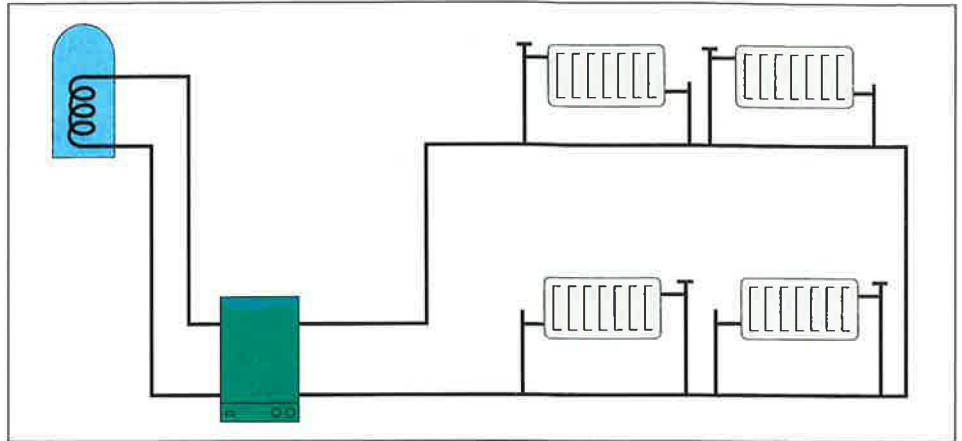
	5-6 years
	4-5 years
	less than 4 years

Comfort

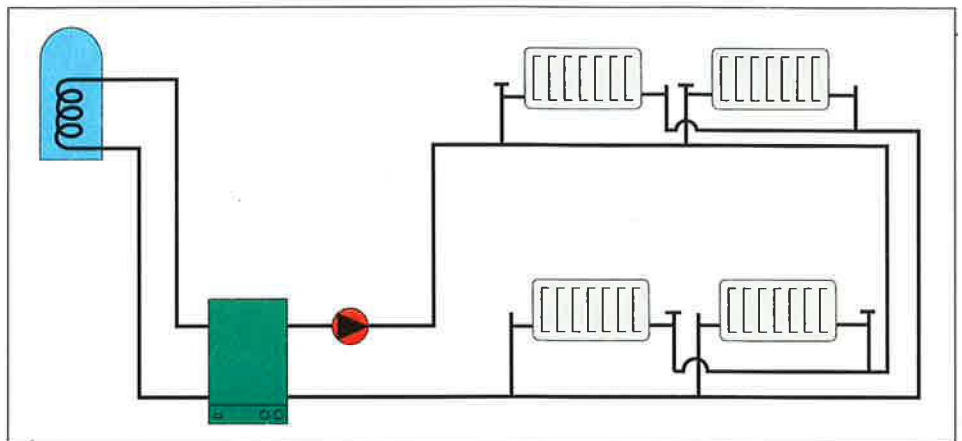
	Some comfort improvement
	Good comfort improvement
	High comfort improvement

GRAVITY SYSTEMS

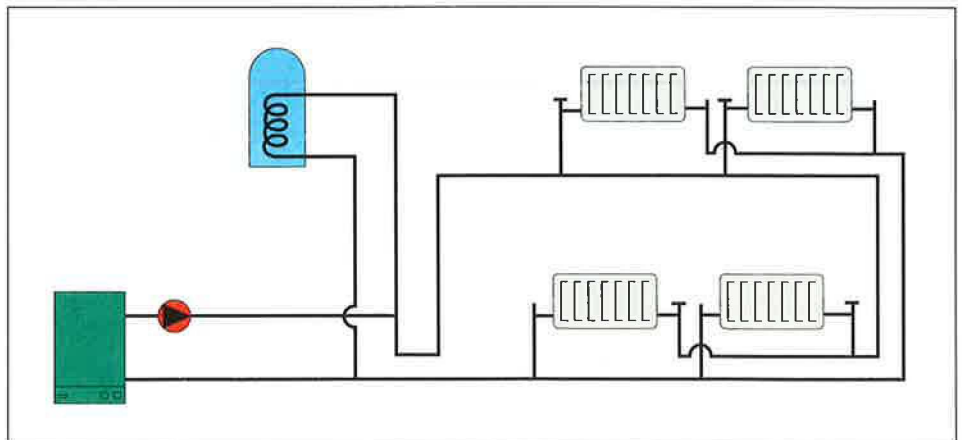
This is the least efficient type of central heating system found in the UK. Householders find it difficult to control. The slow heat up time and poor response to changes in weather cause initial underheating followed by overheating. The system is inherently more expensive to run and does not provide adequate levels of comfort. Adding better controls to gravity systems without upgrading to fully pumped is not recommended as it does not overcome the basic problems experienced with gravity circulation.

**SEMI-GRAVITY SYSTEMS**

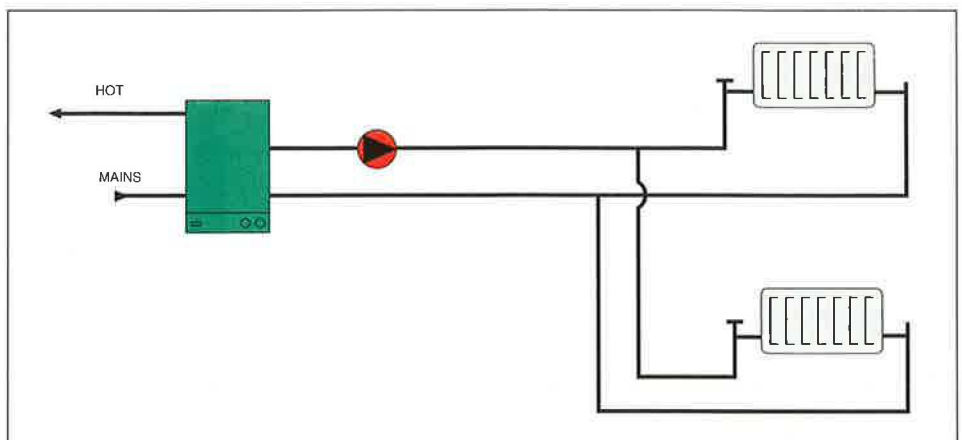
Although the heating is pumped in these systems, the gravity hot water is still difficult to control. Hot water temperatures are generally too high and the system is slow to respond to large hot water demands. High running costs usually make it cost-effective to upgrade to a fully pumped system. In addition, suitable time and temperature control of the heating and hot water should be incorporated.

**FULLY PUMPED SYSTEMS**

These offer improved operating efficiency and reduce cylinder heat up times. They allow heating and hot water to be controlled independently and provide the basis of a well controlled system. However, it is essential to include time and temperature controls which are electrically interlocked with the boiler and pump in order to achieve even better system efficiencies. Without these, even the fully pumped systems can show inefficient and expensive operation with overheating and underheating at certain times.

**COMBI BOILER SYSTEMS**

The lack of a hot water storage cylinder in these systems means that energy is saved that would otherwise be lost from the cylinder. Hot water efficiencies are often high due to the instantaneous nature of this aspect of the boilers operation. However, it is still essential to optimise overall boiler efficiency by controlling room temperatures and minimising running times.



Benefits to installers

This Guide provides installers with useful advice to householders. It should result in fewer complaints about discomfort or excessive room and hot water temperatures.

Given some easily obtained details of an existing heating system, installers should be able to show householders the likely comfort, cost and environmental benefits from an upgrade of their controls. This should lead to more householders taking up suggested upgrades, representing potential increased sales for the installer.

Having made the correct choice of controls for a given heating system it is essential that they are correctly connected. In particular there must be an electrical interlock between the thermostats, programmer, motorised valves and boiler to achieve optimum running conditions and to prevent unnecessary boiler cycling.

Benefits to householders

As the page headed 'benefits' shows, the main advantage to householders of a well-controlled heating system is higher comfort levels. Better control also leads to lower heating costs and reduced CO₂ emissions.

Annual savings in energy bills from a controls upgrade package can be as much as £75 per year for a typical semi-detached house and can repay the cost of the controls package in under 4 years. Energy and cost savings continue well beyond this period.

Emissions of CO₂ from burning fuel in a boiler are reduced in proportion to the fuel used. Emissions from a typical semi-detached house can be reduced by as much as three quarters of a tonne of CO₂ per year.

Better control also gives improved levels of comfort within the home. Rooms are prevented from under or overheating and their temperature can easily be varied according to needs.

Advice to householders

Householders must be carefully instructed how to set and use new controls properly. The operation of programmers in particular can be difficult to understand and householders will receive little or no benefit from an incorrectly set device. They may even waste energy.

As a minimum, manufacturers' instructions should be left with the householder but it will usually be necessary to:

- demonstrate the time control override function
- demonstrate how to set times
- demonstrate how to set summer hot water only
- demonstrate how to alter for GMT
- demonstrate how to set room and cylinder thermostats
- explain that it is best to switch systems off when they are not required
- explain that it is best to turn the room thermostat down to frost protection levels (typically around 12°C) when homes are unoccupied, and

- explain the function of room thermostats and TRVs, eg to be left alone once set rather than used as on/off switches.

Further improvements

The benefits page shows the advantages of upgrading controls to a good level. However, further measures might be worth considering.

Zone control allows two or more zones within the home to be controlled separately. Zones can be heated to different temperatures and at different times to suit requirements. Such a system requires a two-port valve and room thermostat for each zone and a time switch can also be installed where appropriate. This measure is particularly cost-effective in larger properties.

Programmable room thermostats, used with zone control, allow zones within the home to be controlled according to different time schedules and temperatures and are particularly cost-effective for use with combination boilers.

Programmers with two separate time channels enable the householder to set hot water times to be different from heating times and some devices also allow different settings for weekends or individual days.

Frost protection of the house or exposed parts of the heating system can be achieved by the addition of a suitable frost thermostat.

Weather compensators are used to vary the flow water temperature in the heating system automatically depending on outside weather conditions measured by an external sensor. The domestic hot water load is provided by automatically overriding the compensator to reset the flow temperature until the hot water reaches the desired temperature. A three port mixing valve may be required. Weather compensators are normally installed in commercial buildings, but may be suited to larger domestic properties, ensuring that any energy is not wasted in milder weather, further reducing heating costs.

Boiler energy controls are electronic devices which include a weather compensation or load compensation function designed to improve boiler efficiency. These devices often provide other energy saving benefits such as optimum start control, frost protection, night set back, anti-cycling and hot water override.

Boiler anti-cycling controls are electronic controllers that can be set to delay boiler firing to increase the OFF time of the boiler. However, generally speaking, these devices provide little or no improvement to boiler efficiency over and above the controls recommended in this Guide.

Condensing boilers should always be considered when offering advice on upgrading heating systems. They operate very successfully in existing central heating systems and using the standard forms of control recommended in this Guide. Even further savings can be achieved by using weather compensation in conjunction with these highly efficient boilers. Separate detailed EEO guidance is available from BRECSU.

This Guide does not include advice on the installation of controls, partial controls upgrades, or other aspects of system design. For further information contact any of the following:

TACMA

The Association of Control Manufacturers,
Westminster Tower, 3 Albert Embankment,
London SE1 7SL. Tel 0171 793 3008



The Institute of Plumbing,
64 Station Lane, Hornchurch,
Essex RM12 6NB. Tel 01708 472791.



Scottish and Northern Ireland Plumbing
Employers' Federation
2 Walker Street, Edinburgh EH3 7LB.
Tel 0131 225 2255.



Heating and Ventilating Contractors
Association, ESCA House, 34 Palace Court,
Bayswater, London W2 4JG



Institute of Domestic Heating and
Environmental Engineers,
37a High Road, Benfleet,
Essex SS7 5LH. Tel 01268 754266



The Council for Registered Gas Installers,
4 Elmwood, Chineham Business Park,
Crockford Lane, Basingstoke,
Hampshire RG24 0WG.



NAPH & MSC
National Association of Plumbing,
Heating and Mechanical Service
Contractors, Ensign House,
Ensign Business Centre,
Westwood Way, Coventry CV4 8JA.



Energy Saving Trust,
11-12 Buckingham Gate,
London SW1E 6LB. Tel 0171 931 8401.